single blueprint for ERP implementation, the ERP Focus Group recommends a conflict resolution process to resolve differences of scientific opinion regarding ERP priorities or the implementability of a particular project or type of projects. In the event that conflict resolution efforts are unsuccessful at resolving the disagreement at the regional level, the conflict may be elevated to the CALFED Policy Group, or the proposed ERP governing entity, for resolution.

PROJECT LEVEL IMPLEMENTABILITY

At the project selection level, implementability criteria are applied to help reviewers select among competing proposals or among alternatives in the same proposal category. The Focus Group endorses the implementability criteria that have been developed for the 2001 Proposal Solicitation Package (PSP). Some of the project evaluation criteria identified in the 2001 PSP include: scientific merit of a proposal; clearly stated objectives and hypotheses; sound approach for conceptual model, project design, study methods, and analyses techniques; adaptive management approach; adequacy of proposed monitoring, information assessment, and reporting; technical feasibility of proposal; and proponent qualifications. The Focus Group encourages the Restoration Program to adopt the two additional implementability criteria, as follows:

- **CONTRIBUTION TO MULTIPLE OBJECTIVES:** These criteria should be applied at both the regional and the action-specific level. ERP actions should, when possible, interact with other CALFED actions and other related program actions to maximize achievement of synergistic benefits. Examples include ERP actions that benefit Levee Program objectives, or are consistent with the objectives of the AFRP or the Comprehensive Flood Management Study.

- **CONSISTENCY WITH REGIONAL IMPLEMENTATION PLANS:** A proposed ERP project should be consistent with the appropriate ERP regional plans, with regard to habitat types and quantities proposed for restoration. They should also be consistent with the proposed geographic area in the regional plan.

Additionally, planning and action implementation described in the ERP includes three distinct levels of planning: (1) programmatic, (2) regional, and (3) site specific. The programmatic level of planning is presented in Volume II of the ERP. The regional planning process is discussed later in this section. Site specific planning occurs immediately prior to implementation and has been in progress during the CALFED's early implementation of ecosystem restoration projects.

REGIONAL PLAN DEVELOPMENT

The purposes of Regional Ecosystem Implementation Plans are to clearly articulate an integrated planning, implementation, and scientific framework by which to successfully implement and evaluate restoration of the EMAs and EMUs which collectively constitute the Bay-Delta ecosystem. The Regional Plans will provide comprehensive plans of action that will guide proposed restoration actions during development, revision, implementation, and post-implementation periods. The urgency to rehabilitate the ecosystem can be met by addressing scientific uncertainty and proceeding with scientifically defensible Regional Plans and Implementation Strategies.

One of the primary criticisms of the draft ERP is that the plan did not present a clear restoration strategy integrated across the proposed implementation objectives and programmatic actions. The overall Strategic Plan and Regional Plans are designed to rectify this inadequacy by providing clear restoration and implementation strategies that are strongly supported at the local level.

The five important elements of Regional Plans are the what, why, when, who, and how. CALFED and agency staff can assist in the identification of restoration actions and provide a scientific basis for the actions. Other stakeholders may participate and will given the opportunity to assist in the development of actions and the scientific justification for watershed and site specific projects.

CALFED will have a greater role in determining when funding under its purview will be provided for specific projects and will have to judge the merits of numerous individual projects over the entire ERPP study area.

Local watershed groups and conservancies will have a major role in determining who will implement the actions and the manner in which the actions will be implemented. All implementation will have to comply with State and Federal law and which ever contract law (State or Federal) applies to the specific project. CALFED or its participating agencies may be able to enter in direct cooperative agreements or contracts with watershed groups or conservancies that have legal "non-profit" status as a means by which to receive funding and implement restoration actions.

A broad spectrum of participants is required in the development, evaluation, and implementation of the Regional Plans. Local watershed groups, conservancies, individuals, local governments, and State and Federal agencies will be the primary group developing these implementation plans. Other stakeholders will be invited to participate in reviewing intermediate work products. There will also be issue- specific technical workshops closely linked to the overall Strategic Plan which will have a strong link with the development of the local implementation plans.

Development of Regional Plans will require resolution of many issues related to the selection and implementation of restoration actions presented in the ERP. The major issues and areas of concern follow:

- Local participation and empowerment
- Coordination with other restoration programs
- Conceptual ecosystem models
- Implementation management
- Setting priorities
- Establishing measurable success standards
- Accountability

LOCAL PARTICIPATION AND EMPOWERMENT

Successful implementation of restoration programs and projects is composed of many building blocks. The blocks will be placed on a strong foundation of local support and involvement and science. To ensure that the foundation of the restoration program is sound, it is imperative that local groups have not only the desire to participate but also the wherewithal to assist CALFED in designing and implementing restoration actions within clearly defined areas such as an ecological management unit or watershed. In addition, the development, evaluation, and selection of restoration projects must be based on the best available science. Implementation must also be closely linked to monitoring and the collection of scientific data by which to fairly judge the outcomes of restoration efforts.

To accomplish these tasks, CALFED is looking for a consistent approach between ecological management units in developing standards and procedures. Because much of the potential success of the program depends on local support, CALFED must identify ways in which to foster local participation, and ways in which to empower local groups in the decision-making processes and implementation phase.

COORDINATION WITH OTHER RESTORATION PROGRAMS

One of the important values of an effective Local Implementation Strategy is the opportunity in incorporate coordination as one of the key planning elements. The CALFED Program offers new sources of funding and a new approach to restoration that augments and supports many of the existing restoration programs. Major programs that need to be included in the coordination aspect of the Regional Plans include close coordination with the Department of Fish and Game, National Marine Fisheries Service, and the U.S. Fish and Wildlife Service. Each of these agencies has regulatory authorities for implementing programs to protect, enhance, or restore a wide variety of fish, wildlife, and plant species. The Department of Fish and Game is required under provisions of the Salmon, Steelhead Trout and Anadromous Fisheries Program Act (SB 2261) to implement programs and actions to contribute to the doubling of anadromous fish populations over the level that was present when the act became law. The U.S. Fish and Wildlife Service (and the Bureau of Reclamation), under authority of the Secretary of the Interior, are required to implement provisions of the Central Valley Project Improvement Act, many of which address anadromous fish and riparian habitats. All agencies have major responsibilities under the State and Federal Endangered Species Acts to develop and implement recovery programs for listed species.

To improve coordination and project development the Department of Fish and Game and the U.S. Fish and Wildlife Service have independently and cooperatively established field level restoration coordinator positions to assist the agencies, local watershed groups, and conservancies in identifying, developing, funding, and implementing restoration actions. These restoration positions are critical resources than need to be fully integrated into the Regional Plans.

CONCEPTUAL ECOSYSTEM MODELS

The ERP Indicators Work Group has developed draft conceptual models and ecological attributes pursuant to the recommendations of the Scientific Review Panel. Ecological attributes for the Bay-Delta-River System are organized by broad ecological zone designations which include: upland river-riparian systems, lowland river-floodplain systems, Delta, and Greater San Francisco Bay. General categories of attributes were identified (hydrologic, geomorphic, habitat, biological community, and community energetics) which reflect essential aspects of ecosystem structure and function. Understanding the ecological attributes of the Bay-Delta-River system provides a basis for developing conceptual models.

The conceptual models are designed to provide as much consistency across both ecological hierarchy and geography as possible so that information can be aggregated in a variety of ways. Input by technical experts will be more easily integrated using a common format. The next step is to apply these models to individual ecological management areas and units. This will require a critical review of the ecological interrelationships within individual watersheds.

Ultimately, these models, when fine-tuned for individual ecological management units, will provide a further basis by which to evaluate restoration needs, proposed actions, and in refining a process by which to establish restoration priorities.

ECOSYSTEM-SCALE CONCEPTUAL MODELS

Regional Plans need to incorporate conceptual models in the planning process. Ecosystem-scale models include the Upland River-Riparian Systems, Lowland River-Floodplain Systems, and Bay-Delta Conceptual models. The attributes for the Greater San Francisco Bay and Delta have been incorporated by CALFED staff into one model called the Bay-Delta Conceptual Model. As the iterative review process unfolds it may be necessary to develop separate conceptual models for the Greater San Francisco Bay and Delta.

The ecosystem-scale models are based on distinctive geomorphic and hydrologic features which warrant the development of separate conceptual models. For example, upland river-riparian systems are characterized by steep confining topography with bedrock-controlled stream channels in a narrow floodplain. These systems generally occur in upper elevation watersheds above major dams in both the Sacramento and San Joaquin Valley. Hydrologically these areas are characterized by seasonal shifts in stream levels with periodic flooding. The lowland river- floodplain systems are characterized by flat, non- confining topography with a wide floodplain area which allows for active channel migration and floodplain development. These systems have seasonal shifts in stream levels with periodic flooding but also have greater hydrodynamic complexity and large groundwater basins, particularly in the Sacramento Valley.

For undammed tributaries the 300 foot contour was chosen as the dividing line between upland-river riparian and lowland- river floodplain systems. This is the approximate boundary where alluvial soils begin. Often, the location of dams and reservoirs coincides with this boundary. The difference in hydrologic attributes above and below dams warrant using this as a boundary. The uppermost extent of tidal influence was chosen as the boundary between lowland-river floodplain systems and the Delta. Finally, Chipps Island, to coordinate with the legal definition of the Delta, was selected as the boundary between the Delta and the Greater San Francisco Bay.

Habitat-scale Conceptual Models

Conceptual models of habitats need to be developed to depict our current understanding of habitat structure and function. Habitat models could be used to assess technical feasibility and desirability of proposed restoration projects and to evaluate the results of restoration and management actions. A detailed riparian forest habitat model might include such attributes as hydrologic and sedimentation regime; plant composition, diversity and cover; faunal diversity; and reproduction of neotropical migrant birds. Such a model could be used to construct alternative hypotheses regarding, for example, the ecological effects of a levee setback.

Specialized Conceptual Models

Specialized conceptual models include models of individual tributaries, stream reaches, sections of rivers, biological communities, species populations and ecological processes. The Lower American River Conceptual Model is an example of a tributary model that could be used to track local system health and demonstrate the contribution of a particular waterway to landscape-level ecological integrity. The lower American River is essential to the migration, spawning, rearing and outmigration of chinook salmon. Conceptual models and indicators for the lower American River will be developed with the assistance of technical specialists having expertise on this system. For example, the Department of Fish and Game's Stream Evaluation Program, the Water Forum, and Sacramento Area Flood Control Agency technical specialists will likely be contributors to this process. While the general ecological attributes of tributaries in a particular geographic area may be the same, the individual tributary indicators and stressors will likely vary to reflect the different areas of concern for each tributary.

The Interagency Ecological Program's Salmon Project Work Team (PWT) is developing a life history model for Central Valley fall-run chinook salmon and a Steelhead PWT is being formed to assist in the development of a steelhead life history model. Quantitative models of hydrology, sediment transport, and carbon budget are examples of specialized conceptual models of ecological processes. Many other conceptual models have been developed (e.g., oak regeneration, vernal pools, perennial grasslands) that are useful in understanding the dynamic character of watersheds and can contribute to the scientific basis for site-specific project development.

Implementation Management

One of the most difficult challenges in the administration of the ERP is the potential design of the necessary institutional arrangements to ensure implementation of a large program in a large geographic area over a long time period (30 years). Although the nature of the implementation entity for the ERP is not a focal point in developing this Strategic Plan, it remains an important activity occurring outside of the ERP. Some of the important issues to be addressed include fostering a regional perspective, utilizing a "Problemshed" orientation, clearly defining the function of the implementation entity which will then define its structure, integrating strong mechanisms for full accountability of the program, and avoiding a fixed approach to implementation by promoting flexibility and creativity.

Some of the issues that need to be resolved include the overall assurances for implementing the CALFED program. Assurances are the mechanisms necessary to assure that the long-term Bay-Delta solution will be implemented and operated as agreed.

Setting Priorities

Phased implementation is an approach to implement actions identified in the ERPP. Phased implementation is comprised of a multistage priority strategy which assists in identifying and sequencing the implementation of the ERPP restoration actions over time and among the 52 EMUs.

Phased implementation within annual implementation programs will be modified on a recurrent basis as a result of adaptive management and the collection and evaluation of new or improved information. The shorter-term implementation programs developed within the framework of adaptive management may vary significantly from the programmatic snapshot of implementation. This is consistent with the theme of adaptive management and reflects the feedback and evaluation loops needed to refine and adjust the implementation program in the short-term.

Funding

The total for implementing the ERPP has been very roughly estimated at $2.5 billion. About half of that is available through Proposition 204 bond and expected federal appropriations. These funds will be used to provide the initial infusion of capital to move the implementation program forward. In later years, the magnitude of the annual implementation program may be constrained by the annual availability of funding. Phasing, and the overall adaptive management program, is ultimately influenced by the availability of restoration funds throughout the duration of the program, individual and cumulative costs to implement the ERPP, and priority strategies that select for specific actions to reach specific targets.

Establishing Measurable Success Standards

The success of the Ecosystem Restoration Program will be measured at various ecological scales. Generally, the scales will include the landscape (entire ERP study area), ecological zone (four distinct ecological areas), ecological management units (watersheds), abundance trend data for certain species, status of ecological processes, recolonization of restored habitat areas, and the ecological effects of site-specific projects.

The Indicators Work Group will play a major role in defining the measures of success by which to evaluate the progress of the ERP. The measures of success have not been developed at this time, and their development hinges on the refinement and critical review of the conceptual models for important aspects of the ecological processes, habitats, and species within the ERP study area.

Accountability

Because of the large size of the proposed restoration program and the estimated overall financial commitment, a strong program to track expenditures and successes is imperative. The shape of the accountability programs has not been developed but will likely include elements that address financial and environmental aspects of the restoration program.

Demonstration Watersheds

ERP Stage 1 actions will focus on restoring the critical ecological process and reducing or eliminating the primary stressors that degrade ecological health and limit threatened fish populations in several key watersheds of the ERP focus area. Improving the health of the constituent watersheds by restoring ecological processes and reducing or eliminating principal stressors will help to improve the health of the overall Bay-Delta ecosystem.

Stage 1 of the ERP will also include comprehensive, full-scale implementation of restoration actions in selected demonstration watersheds tributary to the Sacramento and San Joaquin rivers. The objective for each of the demonstration watersheds is to create healthy, resilient havens of riparian and aquatic habitat to provide refugia during prolonged droughts or other periods of extreme environmental stress. The approach in the demonstration watersheds is to fully restore the stream corridor within existing constraints (such as large dams) by using a more holistic approach that considers the entire watershed, not just the riparian corridor. Because of the comprehensive nature of restoration actions in demonstration watersheds, the Program will work with local conservancies and stakeholders to help select demonstration watersheds that provide significant potential for large-scale restoration that enjoys local support. Restoring these tributaries into healthy riparian corridors during Stage 1 will also help to recover and maintain large populations of fish species to endure severe ecological conditions such as droughts.

The demonstration watersheds will also serve as laboratories in which resource managers and scientists can test assumptions and hypotheses about ecosystem structure and dynamics and the complex interplay of stressors and how they affect ecological health. The knowledge gained from restoration in the demonstration streams will help to strategically focus restoration actions on primary stressors in other tributaries, as well as clarify how multiple stressors interact to intensify their impacts upon the ecosystem.

Addressing Critical Uncertainties and Impediments to Restoration

Decades of scientific study about the Bay-Delta ecosystem have yielded considerable knowledge about ecological relationships and functions. However, significant uncertainties about Bay-Delta ecosystem dynamics still remain, and they hamper our ability to adequately define some ecological problems or to design effective restoration actions for known problems. The following list of issues indicates substantial uncertainties about Bay-Delta ecosystem dynamics that can be addressed by designing Stage 1 actions to test current assumptions and competing hypotheses about ecosystem structure and function. Many of the following issues deal with uncertainty resulting from incomplete information and unverified conceptual models, sampling variability, and highly variable system dynamics. Developing a better understanding of how these factors affect the ecosystem early in the program will help resource managers to design later restoration actions with greater confidence in their ability to produce desired effects.

The twelve issues described below are listed in approximately increasing order of specificity but not ordered by importance. These issues are not the only ones to consider but must be taken into account to help ensure a successful program.

1. Non-Native Invasive Species

Non-native invasive species (NIS) have produced immense ecological changes throughout the Bay-Delta ecosystem, and they represent one of the biggest impediments to restoring populations of native species. We generally do not understand the mechanisms and pathways by which non-native invasive species affect Bay-Delta ecology, or the underlying mechanisms that give non-native or native species a competitive advantage. Consequently, it is difficult to select, bundle, and design habitat restoration projects so that they favor native species. Nor do we know the basic life history requirements for several non-native invasive species, which complicates the development of control and/or eradication strategies. In order to minimize the risk of potentially massive ecological and biological disruptions associated with non-native species that threaten to negate the benefits of restoration efforts, it is important to initiate an early program that meets the following goals:

- Prevent new introductions and establishment of NIS into the ecosystems of the Bay-Delta, the Sacramento/San Joaquin rivers and their watersheds.
- Limit the spread or, when possible and appropriate, eliminate populations of NIS through management.
- Reduce the harmful ecological, economic, social, and public health impacts resulting from infestations of NIS through appropriate mitigation.
- Increase our understanding of the invasion

process and the role of established NIS in ecosystems in the CALFED region through research and monitoring.

CALFED established the Non-Native Invasive Species program in 1998, which developed both a Strategic Plan (See Appendix E) and an Implementation Plan (See Appendix F) for addressing non-native invasive species in the Bay-Delta ecosystem.

2. NATURAL FLOW REGIMES

Human activities have fundamentally, and irreversibly, altered hydrologic processes in the Bay-Delta ecosystem. For example, changes in land use have affected how and when water drains from the land into stream channels; water diversions have changed the amount of water flowing through tributaries and the Delta; and dam development has profoundly altered the timing, frequency, and magnitude of flows. Extensive water development has generally affected the flow regime by reducing the seasonal and inter-annual variability of flows, as reservoirs capture and store stormwater and snowmelt runoff for later release as water supply. Such changes to the flow regime stress native habitats and species that evolved in the context of a variable flow regime. Restoring variability to the flow regime will be an important component of restoring ecological function and supporting native habitats and species in the Bay-Delta ecosystem.

Restoring variability to flow does not imply restoring a pre-disturbance, natural flow regime, which would be impossible considering the human reliance upon the water supply infrastructure that most affects the character of flow in the Bay-Delta ecosystem. Rather, restoring flow variability will generally mean mimicking the natural hydrograph—imitating the relative timing, magnitude, and duration of pre-disturbance flows.

There will likely be limited opportunities for mimicking naturally low base flows since human water supply and quality needs are so reliant upon the water releases that generally increase base flows. Also, in many reaches, re-creating low base flows may not be desirable from an ecological standpoint. For example, dams have prevented sensitive anadromous species from accessing historical holding and spawning habitats in upper watersheds, but cold water releases from the dams have permitted these fish to survive in reaches downstream of dams. Limited opportunities for re-creating low base flows should not preclude experimental management actions that examine how low-flow conditions affect native and non-native species.

Restoring flow variability will likely focus on mimicking historical peak flows to restore some measure of ecological function and to better create and maintain habitats. However, defining a flow schedule to best achieve ecological restoration objectives on streams regulated by dams is a complex task that must account for the fundamental changes that dams create, including trapping sediments and organic material from upper watersheds, as well as downstream channel adjustments to the post-dam flow regime. Historical reference conditions are instructive, but alone are insufficient to define the flow patterns that will best achieve ecological objectives. Defining ecologically functional flow schedules will also require analyzing current downstream channel and habitat conditions, and developing and testing hypotheses regarding flow requirements for various geomorphic and ecological functions. Research, monitoring, and implementation projects designed to develop a better understanding of geomorphic flow thresholds and hydrologic-biologic relationships will facilitate estimating environmental flow needs, so that environmental dedications of water are effective and efficient in achieving restoration objectives, thereby minimizing potential impacts upon water supply and hydropower generation.

To better define the extent to which rivers regulated by dams can be restored to provide some measure of ecological function, early restoration efforts will need to be accompanied by appropriate research, monitoring, modeling, planning, and feasibility studies. Examples of such projects include:

- Monitoring projects to better estimate geomorphic thresholds, such as the placement and monitoring of tracer gravels and monitoring of water surface elevations to better estimate bed mobility thresholds and gravel routing.

- Historical analysis and modeling to define or refine the non-linear relationships between flow and bank erosion;
- Monitoring to refine stage-discharge relationships and the availability, quality, and use of resultant microhabitats;
- Monitoring and modeling to determine fish passage flows past flow-related barriers;
- Monitoring and modeling to develop or refine flow-temperature relationships;
- Support studies such as an examination of sources of sediment for restoration purposes;
- Research projects that examine the mechanisms underlying native and exotic species responses to flow;
- Simulation and operational modeling to evaluate options for obtaining water to meet environmental needs;
- Monitoring and modeling to develop or refine relationships between flow and contaminant concentrations, bioavailability, and resultant dose and exposure to biota.

Several of the topics noted above can be incorporated into implementation projects. For example, the placement and monitoring of tracer gravels should be a part of any gravel augmentation project implemented to compensate for historical gravel depletion. Similarly, any riparian re-vegetation project should be structured and monitored to enhance our understanding of how native and/or non-native species of riparian vegetation respond to flow components.

3. Channel Dynamics, Sediment Transport, and Riparian Vegetation

Rivers are naturally dynamic. They migrate across valley floors as flows erode banks and deposit sediment on point bars; they occupy different channel alignments through channel avulsion; they periodically inundate floodplains; they recruit and transport sediment; and they drive the establishment and succession of diverse riparian plant communities. These physical processes provide the energy and material necessary to create and maintain healthy and diverse riverine habitats that support native populations of plants, fish, and wildlife. There is a growing recognition that the preservation of existing habitat, and the physical creation of new habitat, must be accompanied by the restoration of physical processes, not only because they help create and maintain these habitats, but also because they are fundamental determinants of habitat conditions in themselves. Restoring ecological processes as a means of restoring habitat conditions is a signature feature of an ecosystem-based management approach.

Human activities have generally reduced the dynamic processes of Central Valley tributaries, with a resultant loss of riverine habitat. Dams have reduced the peak flows essential for shaping and re-shaping channel forms and for connecting river channels with their floodplains. Dams also trap sediment and woody debris from upstream reaches, depriving downstream reaches of the fundamental building blocks for habitat. Levees and bank protection have also prevented channel migration and reduced connectivity between channels and floodplains.

It is generally infeasible to restore fully dynamic rivers because of irreversible historical changes and continued human uses. However, river channels and floodplains may be dynamic on a smaller scale so as to restore some measure of ecological function. For example, rivers can be scaled down by providing space for its meanders to migrate, though not the full floodplain width that it historically meandered across. Similarly, we can introduce coarse sediment and large woody debris into a channel to compensate for the material trapped by dams, but without attempting to match the historical scale of such material inputs. Channel-floodplain connectivity can be increased without restoring the full extent of historical floodplain inundation. While we may be able to restore ecosystem function by restoring riverine processes at a reduced scale, we cannot scale down a river indefinitely, as there are basic thresholds below which a river will cease to function. For example, there are minimum threshold flows required to initiate important geomorphic functions such as bed mobility, bank erosion, and overbank flooding.

We generally do not know the scale and balance of inputs--flow, sediment, organic material--and channel modifications that will restore riverine ecosystem function. Nor do we know how channels and habitats downstream of dams have adjusted to the post-dam flow regime and how, therefore, the re-invigoration of dynamic riverine processes will affect overall habitat. Restoring geomorphic processes so as to optimize ecosystem benefits will be a matter of both analysis and experimentation. It is also important to identify locations in the Bay-Delta ecosystem that still have, or can have, adequate flows to inundate floodplains and sufficient energy to drive channel migration.

4. FLOOD MANAGEMENT AS ECOSYSTEM TOOL

River-floodplain interaction is a vital component of riverine health. When inundated, floodplains provide valuable habitat for a multitude of species. They can also supply sediment, nutrients, and large woody debris to river channels, and provide a place for fine sediment deposition, which is an important function in light of flushing flows designed to cleanse spawning gravels. Inundation of floodplains also contributes to diverse structure of riparian vegetation. Human activities have aggressively and deliberately isolated floodplains from river channels, most clearly through levees designed to confine flows in channels. Dams have also contributed to floodplain isolation by reducing peak flows necessary to inundate floodplains.

Floodplains also provide storage of floodwaters, and there is growing interest in reconnecting rivers with their floodplains as part of a comprehensive flood management strategy. Large floods in the Mississippi River Valley and Central Valley in the last decade have exposed weaknesses in a purely structural approach to flood management and nurtured a growing recognition that we can never eliminate floods. For example, levees pulse floodwaters downstream more quickly, which provides local flood protection by transporting flood burden and risk downstream. In contrast, floodplains can actually store floodwaters and generally reduce overall flood risk by gradually metering flow back into the channel over time. For example, an analysis of hydrologic data for some Central Valley tributaries during the '97 floods indicates rising flows beginning to plateau as upstream levees were breached. The plateau effect demonstrates the ability of the floodplain to absorb part of the discharge, thereby attenuating the peak flow and reducing flood pressure on downstream reaches.

The Army Corps of Engineers, the Department of Water Resources, and the Reclamation Board are engaged in a Comprehensive Study of the Sacramento and San Joaquin River systems to examine opportunities for improving flood management through both structural and non-structural options. The Comprehensive Study and CALFED represent an important opportunity to integrate flood management and ecosystem benefits by reconnecting rivers with their floodplains.

Flood management can also provide ecosystem benefits through the evacuation of reservoir space for flood reservations. Many dams in the Central Valley reserve a certain portion of reservoir capacity to capture floodwaters, so as the rainy season approaches, dams must often release flows to evacuate water that occupies flood reservation space. Such flood management releases have the potential to provide significant ecosystem benefits if they are released to mimic the peak flows that are essential for restoring geomorphic processes.

Integrating and balancing flood management and ecosystem benefits will require several activities and adaptive management experiments. Some of the activities and actions include:

- Identifying and acquiring floodplain land or easements to provide opportunities for restoring channel-floodplain connectivity and testing flood management and ecosystem benefits;

- Quantifying the flood management benefits of floodplain storage;

- Examining opportunities for restoring river-floodplain connectivity without compromising development, such as protective ring levees, setback levees, or floodproofing;

- Re-grading existing floodplains on regulated streams so that they inundate more frequently in the context of post-dam flow regime, to facilitate testing flood management and ecosystem benefits;

- Clarifying how ecosystem restoration efforts, such as riparian re-vegetation, gravel augmentation, and channel reconstruction projects, affect flood conveyance capacity;

- Identifying hydraulic constrictions/choke points that prevent managed flow releases to inundate floodplains, and exploring options for addressing them; and

- Exploring opportunities to re-construct levees to provide some measure of habitat without reducing levee strength or reducing conveyance capacity.

5. Bypasses as Habitat

The Yolo and Sutter Bypasses along the Sacramento River provide important flood management benefits in the Sacramento Valley and downstream urban areas. The realization of their relatively low-cost benefits to flood control is leading to the consideration of additional bypasses, especially in the San Joaquin Valley. The bypasses accommodate multiple uses; during the dry season, they are important areas for farming, and when flooded they provide important habitat for waterfowl, fish spawning and rearing, and possibly as sources of food and nutrients for estuarine foodwebs. For example, when the Yolo Bypass is flooded, it effectively doubles the wetted surface area of the Delta, mostly in shallow-water habitat. More frequent inundation of existing flood bypasses and the creation of new bypasses could expand the ecosystem benefits that they provide, but managing the bypasses for the benefit of fish and wildlife must be balanced with their use for flood control and farming. Achieving this balance of flood management, land use, and ecosystem benefits will require activities such as:

- Evaluating structural alternatives for directing water into bypasses so that they inundate more frequently;

- Experimenting with different inundation scenarios to study fish and wildlife preferences and benefits;

- Identifying opportunities for new flood bypasses and how they can be designed to benefit fish and wildlife;

- Examining how ecosystem habitats affect flood conveyance of bypasses;

- Evaluating the relative importance of flood bypass contributions to estuarine foodweb productivity;

- Studying what multiples uses are compatible in flood bypasses (e.g., what types of agricultural practices used in the bypasses and what types of fish and wildlife use are and are not compatible)

Recent studies of flooded bypasses demonstrate their importance for several sensitive fish species. There is some question, however, if the bypasses can be used as models for floodplain restoration actions along Bay-Delta tributaries, or if the bypasses constitute unique habitats.

6. Shallow-Water Tidal and Freshwater Marsh Habitat

Both tidal and freshwater wetlands (marsh habitats) represent critical areas for many key species, including species that are threatened or endangered or that have commercial and/or sport value. A significant portion of historical wetlands have been lost to human uses, so the ERP will restore wetland habitats throughout the Bay-Delta ecosystem as part of an ecosystem-based